

CONTENTS

1.	INTRODUCTION	1
2.	NON-DESTRUCTIVE ANALYSIS	5
2.1.	Gamma ray spectrometry	5
2.1.1.	Gamma emission and detection of nuclear materials	5
2.1.2.	Hand-held multipurpose gamma spectrometry	6
2.1.3.	Multichannel analysers	9
2.1.4.	IAEA high resolution gamma spectrometry techniques	10
2.2.	Neutron counting	11
2.2.1.	Neutron emission and detection for non-irradiated fissile fuel	II
2.2.2.	Gross neutron counting	14
2.2.3.	Neutron coincidence counting	14
2.3.	Spent fuel measurement	18
2.3.1.	Neutron emission and detection	18
2.3.2.	Gross neutron and gamma ray detection	20
2.3.3.	Gamma ray energy spectral analysis	20
2.3.4.	Gamma ray intensity scanning	21
2.3.5.	Cerenkov radiation detection	22
2.4.	Other NDA techniques	23
2.4.1.	Radialion measurement	23
2.4.2.	Physical property measurement	24
3.	DESTRUCTIVE ANALYSIS	26
3.1.	Elemental analysis	27
3.1.1.	Uranium by potentiometric titration	27
3.1.2.	Plutonium by potentiometric titration	29
3.1.3.	Plutonium by controlled potential coulometry	29
3.1.4.	Uranium by ignition gravimetry	29
3.1.5.	Uranium, thorium or plutonium by K-edge X ray densitometry .	30
3.1.6.	Plutonium by K X ray fluorescence analysis .	30
3.1.7.	Plutonium and/or uranium by wavelength dispersive X ray fluorescence spectrometry .	31

3.1.8. Uranium or plutonium by isotope dilution mass spectrometry	.3	2
3.2. Isotope analysis .33		
3.2.1. Uranium or plutonium isotopic composition by thermal ionization mass spectrometry .33		
3.2.2. Plutonium isotopic composition by high resolution γ ray spectrometry .34		
3.2.3. Uranium-235 in solution by γ ray spectrometry .34		
3.3. Other DA techniques .34		
4. CONTAINMENT AND SURVEILLANCE		36
4.1. Surveillance .36		
4.1.1. Installed single cameras for easy to access locations .43		
4.1.2. Installed single camera for difficult to access locations .43		
4.1.3. Installed multi-camera .44		
4.1.4. Short term surveillance .45		
4.1.5. Underwater TV for attended applications .46		
4.1.6. Surveillance review software .47		
4.1.7. Miscellaneous surveillance systems and options .48		
4.2. Seals .48		
4.2.1. Single use seals .49		
4.2.2. In situ verifiable seals .50		
5. UNATTENDED MONITORING .54		
6. REMOTE MONITORING SYSTEMS .61		
6.1. Remote monitoring equipment .61		
6.2. Future development activities .62		
6.2.1. Data reduction .63		
6.2.2. Alternative communication methods .63		
7. DATASECURITY .65		
7.1. Information protection requirements .65		
7.2. IAEA requirements .68		
7.2.1. Verification data .68		
7.2.2. Technical data .70		
7.2.3. Control data .71		

7.3. Member State requirements	72
8. ENVIRONMENTAL SAMPLING	75
X.1. IAEA Clean Laboratory for Safeguards	75
8.2. Screening of samples	77
8.2.1. Low level γ ray spectrometry	77
X.2.2. X ray fluorescence spectrometry	78
X.2.3. Alpha/beta counting	78
X.3. Isotopic and elemental analysis	78
X.3.1. Pulse counting thermal ionization mass spectrometry ..	78
X.3.2. Scanning electron microscopy with electron probe analysis	7 9
X.3.3. Fission track method	80
8.3.4. Secondary ion mass spectrometry	8 2